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PERMEABILITY OF STONE

A property of stone which has been studied but little and which has often been left out of consideration entirely by practical men is its permeability. Since it is very important to maintain the interior of buildings as dry as possible, it is evident that a knowledge of the relative permeability of the various materials used in wall construction will be of value in the selection of a material for a given purpose. All stones, both natural and artificial, are porous, but not to the same degree. Some stones are so dense that only a very small amount of water can pass through them, while others are so porous that they offer but little resistance to the passage of water.

While the permeability of stone is of interest mainly in connection with the prevention of dampness in masonry buildings, it also has other applications. In connection with the durability or resistance to frost it appears that the permeability of a stone has considerable bearing on these properties. Efflorescence on masonry is a source of annoyance, not only because it produces an unsightly appearance but it frequently causes extensive deterioration. Since efflorescence is due largely to the leaching of water through the masonry which carries water-soluble materials to the surface, it is evident that permeability is a consideration of importance in this problem. Further, knowing this property of a stone, it appears that a permeability test affords a sound basis for determining the value

of various waterproofing materials and methods when applied to different types of stone.

From time to time a number of studies have been made of the permeability of concrete, but very few measurements have been made to determine this property for other materials. Recently an apparatus has been developed at the bureau for experiments on natural stones. Several types of stone have been studied in a series of preliminary tests for comparative data and to determine the adaptability of the apparatus to a considerable range of materials.

A paper describing the new permeability apparatus for making these tests and giving the data obtained by experiments on several materials is now being prepared as one of the bureau's publications.

ADHESION OF GYPSUM PLASTER TO CONCRETE

At the request of the committee on gypsum of the American Society for Testing Materials, two short experiments have been carried out in conjunction with a study of the linear expansion of gypsum. From the results obtained in some previous work a number of conclusions were drawn. One conclusion reached was that if a particular gypsum mix had an expansion approximating that of a particular concrete, under the same conditions, that gypsum mix might be expected to have good adhesion to the concrete. If, on the other hand, the particular gypsum

mix behaved in great variance with the concrete, that gypsum mix would probably not give as good adhesion to the concrete.

The first experiment carried out was to test some of the brands of calcined gypsum and the concrete used in the previous work to see what loss of adhesion they would show when subjected to humidity changes. The method of testing was to make up six half briquets of a particular 1:3 cement mix, and after the cement had set the other half of the mold was filled with the gypsum mix.

After the mortars had set the briquets were removed from the molds and allowed to dry in the laboratory for seven days. The strength of the bond between the cement and the gypsum was then tested, three briquets being broken in the usual manner. The remaining briquets made from the various samples of gypsum were placed under water for five hours and then allowed to dry in the laboratory for seven days. The strength of the bond between the gypsum and the cement in these briquets was then tested as before.

The results of these tests showed that the brands of gypsum which gave expansion curves similar to the concrete gave good adhesion to concrete and a small loss only in adhesion when subjected to humidity changes. The brands of gypsum giving expansion curves in great variance with the curve for concrete showed poor adhesion values.

The second experiment carried out was a study of the linear expansion changes of a concrete and of the coats of plaster as they were applied to the concrete. The method consisted in making up 2 by 4 by 12 inch specimens of 1:2:4 concrete. These specimens were fitted with two plugs made from capillary glass tubing, placed in the mortars 10 inches apart. Expansion readings were made from these plugs, using a 10-inch strain gauge. The concrete specimens were allowed to dry in the laboratory for 30 days, and then a one-half-inch coat of a 1:2 gypsum-

sand mix was applied to the slabs. Short pieces of glass tubing were placed around the glass plugs in the concrete so that the expansion readings of the concrete were not affected. Another set of plugs was placed in the first coat before it set. Expansion readings were made hourly on the concrete for about 24 hours, after which a one-half-inch second coat was applied, using a 1:3 gypsum-sand mix. Before the application of the second coat short pieces of glass tubing were placed around the plugs in the first coat in order to avoid affecting the expansion readings of the first coat. A third set of plugs was placed in the second coat before it had set. Expansion readings for both the concrete and the first coat were made hourly for about 24 hours. Then a thin white finish coat of lime and gauging plaster was applied, and expansion readings for the concrete and first and second coats were continued for 14 days. It was found that the concrete has a relatively great expansion when the first coat is applied, less expansion when the second coat is applied, and a very small expansion when the third coat is applied. The first coat has a relatively great expansion when the second coat is applied, but only a small expansion when the third coat is applied, while the second coat shows only a small expansion when the third coat is applied.

STUDY OF CLAY DRYING

In the course of the investigation which the bureau is conducting on the drying of clay wares it was thought desirable to determine, if possible, the rate of flow of water from the center of the specimen to the surface. It has been a popular conception that a heavy piece of clay ware when dried rapidly would quickly lose water by evaporation from the hot surfaces, causing the formation of a skin of dry clay while the center remained wet and comparatively cool.

It was thought, therefore, that the rate of water flow could be indicated

by the comparison of depths of other points.

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by the use of differential thermocouples, comparing temperatures at various depths in a wet specimen with each other and also with corresponding points in a previously dried specimen.

Copper-constantan thermocouples were used and the temperatures were recorded by means of a Leeds & Northrup type K potentiometer. The couples were placed one-half inch from the top surface, at the center, and one-half inch from the bottom surface of 4-inch cubes, one of which, as previously stated, was dried and the other in the plastic condition.

In the first test the specimens were subjected to a high relative humidity (95 per cent) for five hours, during which time the temperature was raised to 95° C. The relative humidity was then rapidly lowered while the temperature was raised to 135° C. The plastic specimen cracked badly because of this treatment, and while there was an appreciable difference between the temperature in the dry cube and in the cube which was being dried it was found that the maximum temperature difference in the latter at no stage exceeded 8° C.

In the second test the relative humidity at the beginning was appreciably lower than in the first (66 per cent) and was gradually lowered in seven hours to 10 per cent while the temperature was raised to 93° C. In this test the specimen again cracked badly, but the maximum temperature difference between any point in the specimen which was being dried did not exceed 2°.

This work indicates that a clay body containing moisture has a rather high coefficient of thermal conductivity which enables heat to be supplied to all parts of a comparatively large specimen even during extreme drying conditions and consequent rapid evaporation. It further indicates that the successful drying of heavy clay ware is dependent almost entirely on the ability of the clay structure to permit the water to come to the surface rather than on a combination of factors involving ability to conduct heat to the center of the ware.

FLOTATION OF ENAMELS

The problem of improving practice in preparing enamels for application to metal shapes previous to firing has attracted considerable attention among enamelers because of the difficulty of maintaining a slip of uniform consistency. Accordingly, the bureau has undertaken a study of the factors governing the behavior of enamels suspended in water, as used for coating metal shapes.

Enamel frit, of glasslike consistency, shattered by sudden cooling in water or air, is ground in ball mills with water, addition of clay and a salt usually being made to help keep the particles of frit in suspension. The metal shapes may be coated with this slip by either dipping or spraying, and either method requires that the slip be uniform in consistency from day to day. Two methods are being employed in investigating the problem. One is to study in a fundamental way the mechanism of known changes in properties due to variations in method of preparation. The other is to vary the kinds and amounts of the constituents and note their effect upon the important physical properties of enamel slips.

In the more fundamental method of investigation several types of experiments were made, including the following: (a) Spectroscopic examination showed that materials dissolved from the frit during grinding contained sodium, potassium, silicon, aluminum, calcium, manganese, nickel, and in some cases other elements; (b) tests upon finely ground frit and clay (separate constituents of enamel slip) showed that a particular salt commonly used for adjusting the consistency of slips had quite different effects upon the respective suspensions of these materials; and (c) this fact suggested the possibility that the two materials in suspension carried opposite electrical charges. Study of the movement of the particles under the influence of an electric current, however, indicated that the charges were alike.

Tests made in accordance with the second method of study indicate that the practice of discarding mill water, which has accumulated on top of enamel slips upon standing, tends to reduce the thickness of the coat in which they are able to adhere when applied to the metal. The composition of the frit, which influences the properties of the liquid phase because of its effect on the solubility of the frit, also affects this thickness.

NICKEL IN HIGH-SPEED TOOL STEEL

An attempt is usually made to avoid the introduction of nickel into high-speed tool steels, although cobalt, which is chemically very similar to nickel, is generally considered a useful addition to such steels. This is just the reverse of the situation found in alloy steels for automotive use, for example, in which nickel plays a useful rôle, while cobalt is not used.

Some high-speed tool steels contain small amounts of nickel coming from the melting stock used. It is increasingly difficult to secure melting stock free from nickel, because of the use of scrap in blast furnaces and in steel-making processes. With the prevalence of alloy steel in present-day industrial uses, any lot of scrap is almost certain to contain some nickel steel.

The performance in taking roughing cuts of high-speed tool steels made up in the laboratory, to which relatively large amounts of nickel were intentionally added, was studied at the bureau. Three and a half per cent nickel in the low tungsten or high tungsten types of high-speed steel was found to have no injurious effect upon the life of the tool. With the normal carbon content, however, the machining qualities of the annealed steel were adversely affected, the steels being almost impossible to machine. Tools formed by grinding gave good performance.

By reducing the carbon content from 0.7 to 0.5 per cent the steel which contained 3.5 per cent of nickel could be machined and showed normal performance in roughing cuts. These ex-

periments indicate that small amounts of nickel in a high-speed tool steel, the carbon content of which is properly regulated, should exert no deleterious effect.

This work was a part of the study of the effect of nickel, cobalt, tantalum, and molybdenum in high-speed tool steel, which will soon be published in full in the Transactions of the American Society for Steel Treating.

THERMAL EXPANSION OF TUNGSTEN

A manuscript entitled "Thermal Expansion of Tungsten" has been completed. This paper gives the results of an investigation on the thermal expansion of tungsten (99.98 per cent) over various temperature ranges from about -100 to $+500^{\circ}\text{C}$. A summary of available data obtained by previous observers is included. The expansion of tungsten is given by the following empirical equation:

$$L_t = L_0 [1 + (4.28 t + 0.00058 t^2) 10^{-6}]$$

where L_t represents the length of the metal at any temperature t between -105 and $+502^{\circ}\text{C}$. and L_0 = length at 0°C .

MOUNTING MEDIUM FOR HOLDING GOLD ALLOY SPECIMENS DURING POLISHING

In searching for a satisfactory mounting medium to hold gold alloy specimens while polishing for micrographs the bureau has found that sulphur serves remarkably well. It can be melted and poured over the specimen without excessive heating of the alloy. It polishes well and does not scratch the softest gold surface as it is shaped by the abrasives. The shrinkage of cast sulphur, which takes place in a few days, causes it to drop readily from the ring or tube in which such specimens are usually mounted. Specimens are thus prepared, without excessive expenses for the medium and with no danger of injury in removing from the ring or tube.

As sulphur is a nonconductor, the surface of the gold etches without the elec-

trolytic complications which are so troublesome when specimens are mounted in metallic media.

TESTING OF SIEVES

Occasionally some interesting developments takes place in connection with the regular testing work of the bureau, as well as in its investigational work; for instance, in the testing of sieves, those submitted directly by manufacturers have, as a rule, shown progressive and very commendable improvement. Sieves sold to customers and by them submitted to the bureau for test have not proven as satisfactory. This is a strong argument for the plan of purchasing certified sieves from the manufacturers and dealers as against the plan of purchasing uncertified sieves to be submitted for test by the purchaser. The manufacturers do not wish to carry out tests so that they can guarantee their own sieves, and thus sell them on the understanding that those which may later be found unsatisfactory by this bureau will be replaced.

It is also noted that there is continued trouble in obtaining good coarse sieves. This is not regarded as being very serious, the percentage of errors being small in many cases. The cost of the coarse reeds and other equipment for making these cloths is relatively small and the mechanical precision less exacting as compared with the finer sieve cloth, so that it would appear that this will adjust itself in time.

The adoption of the United States Standard Sieve Series by the American Society for Testing Materials as tentative specifications for that society with serial designation E 11-25 T, is another step toward the unification of sieve requirements.

ACIDITY CONTROL IN PAPER MAKING

The importance of acidity in paper making is well understood, the best results in the sizing, tinting, and filling processes and in the formation of paper on the machine being dependent to a

considerable extent upon control of acidity within narrow limits. Indicator paper (litmus) is commonly used to detect acidity and titration to measure it. It is now believed that titration shows only the quantity of acid present and not its intensity. Since the activity of acid is determined by its intensity, a preferable method of measurement is determination of the hydrogen ion concentration. Such determination has been made a regular part of all paper-making operations in the bureau's semicommercial mill.

A report has been prepared for publication in a trade journal giving a description of the method evolved and some results obtained with its use as applied to the sizing of paper. It was found that the optimum acidity for the stock at the paper machine is from 5.0 to 5.5 pH. The amount of paper maker's alum required for satisfactory results is minimum at the optimum value, and the quantity in excess of that required to produce this value has no favorable effect on sizing. It is possible, therefore, to effect considerable saving in alum by using the method for control of acidity, and more uniform results in sizing no doubt would be obtained.

It is pointed out also that improved results in other paper-mill processes, such as purification of the fresh-water supply and in coloring paper, should result from the accurate acidity control made possible by such method as described.

GRAY DISCOLORATION ON WHITE WOOLENS IN DRY CLEANING

Considerable difficulty has been experienced in commercial dry-cleaning establishments during the usual process of cleaning white woolen garments, because it has been found that the garments after cleaning have a grayish hue. This problem was brought to the attention of the research associate of the National Association of Dyers and Cleaners stationed at the bureau to determine the cause, and, if possible, means of eliminating it.

Corrosion was caused by the electrolytic action produced when a benzine soap (caustic-oleic acid) was introduced into the naphtha in the presence of the zinc and iron which are used for lining the cleaning wheel. The sulphur and unsaturated hydrocarbon which occur as impurities in the naphtha combined with the metals freed in the electrolytic action to form sulphides, which in turn combined with the soap and oil to form a gray discoloration on the fabric.

Since the cause is inherent in the present equipment, it was suggested that new types of apparatus should be used. These should be made or lined with some noncorrosive material.

VALUE OF TESTS OF TIRES

The endurance machine for testing tires, which was installed at the bureau some time ago, has proved to be of great value to the tire industry aside from its use in testing tires for Government purchases. In addition to the latter tests, at least 15 different tire manufacturers have availed themselves of the bureau's facilities by requesting that the bureau conduct tests on certain of their tires to determine whether or not they conform to the Government standards.

Two tests of a series of six tires each made for two manufacturers illustrate the points which the tests bring out. In one case it was plainly shown that a weakness existed in the construction of the bead of the tires, and in the other case it was apparent that a change should be made in the methods of manufacture, as the different plies in the tire were not adjusted for equal tension, which caused premature breaking of the carcass. In these particular cases, as well as in many others, manufacturers have stated that the results are of great value to them and have aided them to improve their product by strengthening weaknesses which were shown to exist. One of the big elements in tests of this kind is the speed with which they can be made compared with the time which would be required for road tests. A test can be completed on the machine in

about four days which would ordinarily take from six months to a year on the road.

MEASUREMENT OF FIELD INTENSITY OF BROADCASTING STATIONS

The factor which determines the strength of signal produced in a radio receiving set by the waves from any transmitting station is the field intensity produced by the station. This field intensity is not determinable from a knowledge of the power of the transmitting station, and so the interference caused by a station at a given point is measured not by the station's power but by the field intensity which it produces.

During the past few months the bureau has been making a study of the several methods hitherto used for the measurement of field intensities and is developing methods and apparatus suitable for such measurement for various purposes. A portable apparatus is being developed for the supervisors of radio, so that they may be equipped to measure the field intensity of transmitting stations and thus regulate the power of the stations so that they do not produce excessive interference.

With the advent of higher-power broadcasting this summer, the bureau has measured the field intensities produced at Washington by a number of the higher-power stations. These measurements have shown that the effect of the higher power is to produce louder signals and to increase the radius of the small zone around the broadcasting station in which there is freedom from atmospheric disturbances ("static") and other interference. This gain is not proportional to the increase of power. The higher power does not materially increase the interference produced by the stations. The signal fluctuation (fading) at a distance is not reduced by higher power and limits the zone of satisfactory reception.

One of the greatest obstacles to good radio reception is fading. The bureau, in cooperation with about 40 other laboratories has been making graphical

records of fading on prearranged schedules to study the changes in fading during the sunset period. Accurate knowledge of the sunset-fading phenomena should throw light on the nature and causes of fading. These fading records give a comparative record of the variation of the field intensity but do not give actual values. Methods are being developed so that these fading records will give the values of the field intensities. Persons interested in participating in this cooperative program of radio measurements are invited to communicate with the Bureau of Standards, Department of Commerce, Washington, D. C.

DRY BATTERIES FOR RADIO USE

The attention of the bureau has again been called to the frequent misuse of its name in connection with the sale of dry batteries for radio receiving sets. Claims have been made by some dealers and factory representatives that the superiority of their particular brands of batteries has been shown by tests made at the Bureau of Standards. Tests of batteries, including the dry-cell "A" and "B" batteries for radio use, are made at the bureau in accordance with Government specifications. These tests are made to aid the departments of the Government in the purchase of batteries and to help each manufacturer to improve his product. The bureau does not publish the results of its tests, nor does it inform any manufacturer of the results of its tests on other manufacturers' batteries. Therefore statements that any make or brand of battery is superior as shown by tests made at the Bureau of Standards are unwarranted.

NATIONAL DIRECTORY OF COMMODITY SPECIFICATIONS

The National Directory of Commodity Specifications, work on which has been in progress at the bureau during the past two years, is now on the press and will shortly be ready for distribution.

This directory contains in convenient form information regarding the best-

known specifications for more than 6,000 commodities. The book tells not only what specifications are in general use but also by whom they were prepared and where copies can be obtained. In it are conveniently indexed for ready finding about 27,000 specifications prepared by the Federal Specifications Board and the separate departments of the Federal Government, by State and city purchasing agents, public utilities, technical societies, and trade associations.

The contents include a statement and indorsement by the advisory board, a foreword by Secretary Hoover, and a thoroughly classified list of specifications for all types of commodities. There are also included an alphabetical list of commodities, which serves as an index to the specifications, and directions for obtaining copies of specifications listed in the directory.

Summary of commodities and specifications therefor

| Decimal class | Commodity groups | Commodities indexed | Approximate number of specifications |
|---------------|--|---------------------|--------------------------------------|
| 000 | Animal and animal products..... | 350 | 1,600 |
| 100 | Vegetable food products, oil, seeds, expressed oil, and beverages..... | 525 | 2,100 |
| 200 | Other vegetable products (except fibers and wood)..... | 400 | 800 |
| 300 | Textiles..... | 275 | 1,900 |
| 400 | Wood and paper..... | 625 | 3,300 |
| 500 | Nonmetallic minerals..... | 725 | 3,300 |
| 600 | Ores, metals, and manufactures (except machinery and vehicles)..... | 1,700 | 6,400 |
| 700 | Machinery and vehicles..... | 800 | 2,900 |
| 800 | Chemical and allied products..... | 600 | 2,400 |
| 900 | Miscellaneous..... | 650 | 2,400 |
| | Total..... | 6,650 | 27,100 |

Official representatives of 14 leading national societies interested in specifications served as members of a board organized to act in an advisory capacity in connection with the preparation and publication of the directory. The board is composed of representatives of the

American Electric Railway Association; American Engineering Standards Committee; American Hospital Association; the American Hotel Association; American Society for Testing Materials; Associated Business Papers (Inc.); Associates for Government Service (Inc.); Chamber of Commerce of the United States; National Association of Manufacturers; National Association of Purchasing Agents; National Conference of Business Paper Editors; National Conference of Governmental Purchasing Agents; National Electric Light Association; and the Society of Automotive Engineers.

In accordance with the recommendations of the advisory board use has been made of the decimal system of classification, the specifications being classified according to the source rather than the use of the commodities, and the book is being printed on standard catalogue-size sheets in the dictionary or reference-book style. It is bound in cloth and printed in small but legible type, and thus the number of pages has been reduced to the minimum, 385, without sacrificing the usefulness of the directory.

The cost of printing and binding the book to the Government Printing Office is \$1.25. The price to the purchaser is the same.

The directory is to be followed by an Encyclopedia of Specifications and a Treatise on Specifications, which will also be sold at the actual cost to the Government Printing Office.

The treatise will deal with the selection, use, and limitations of specifications and methods of testing, and the encyclopedia will contain actual copies of one or more outstanding specification for each commodity or group of commodities. In the encyclopedia there will be reproduced initially such worthwhile specifications as are difficult to secure, giving due consideration to the monetary value of the commodities covered by the specifications. The encyclopedia will be in loose-leaf or loose pamphlet form, so that you need buy only such specifications or groups of specifications as you can make use of.

These publications can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at the prices given above.

The treatise and the encyclopedia will be issued as rapidly as conditions will permit.

PUBLICATIONS OF THE BUREAU OF STANDARDS RELEASED DURING AUGUST

Scientific Papers

S508. Spark photography and its application to some problems in ballistics; Philip P. Quayle. Price, 20 cents.

Technologic Papers

T286. Comparative durability of chrome and vegetable tanned sole leathers; R. C. Bowker and M. N. V. Geib. Price, 10 cents.

T287. A hot-wire anemometer for measuring air flow through engine radiators; Carl G. F. Zobel and L. B. Carroll. Price, 5 cents.

T288. Comparative cold-rolling tests of open-hearth steel strip (deep-drawing stock) and electrolytic-iron strip; John R. Freeman and R. D. France. Price, 10 cents.

T289. Comparative slow bend and impact notched bar tests on some metals; S. N. Petrenko. Price, 20 cents.

Circulars

United States Government Master Specifications for—

C232. Rubber goods (methods of physical tests and chemical analyses). Price, 10 cents.

C245. Surgical operating pads. Price, 5 cents.

C259. Brown denim (unshrunk). Price, 5 cents.

C263. Cotton waste, colored. Price, 5 cents.

C265. Indigo blue denim (shrunk). Price, 5 cents.

C266. Indigo blue denim (unshrunk). Price, 5 cents.

C270. Mercerized cotton airplane cloth, grade A. Price, 5 cents.

C271. Rubber gloves for electric workers. Price, 5 cents.

C273. Bleached wide cotton sheeting. Price, 5 cents.

C274. Bleached cotton sheets (medium and high count sheeting). Price, 5 cents.

Simplified Practice Recommendations, Elimination of Waste

R36. Milling cutters. Price, 5 cents.

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